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**Please find below and/or attached an Office communication concerning this application or proceeding.**

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**BEFORE THE BOARD OF PATENT APPEALS  
AND INTERFERENCES**

Application Number: 10/656,182  
Filing Date: September 08, 2003  
Appellant(s): MCTEER, ALLEN

**MAILED**

**DEC 03 2007**

**GROUP 2800**

Thomas J. D'Amico, Jennifer M. McCue  
For Appellant

**EXAMINER'S ANSWER**

This is in response to the appeal brief filed 6/12/07 appealing from the Office action mailed 11/3/06.

**(1) Real Party in Interest**

A statement identifying by name the real party in interest is contained in the brief.

**(2) Related Appeals and Interferences**

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

**(3) Status of Claims**

The statement of the status of claims contained in the brief is correct.

**(4) Status of Amendments After Final**

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

**(5) Summary of Claimed Subject Matter**

The summary of claimed subject matter contained in the brief is correct.

**(6) Grounds of Rejection to be Reviewed on Appeal**

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

**(7) Claims Appendix**

The copy of the appealed claims contained in the Appendix to the brief is correct.

**(8) Evidence Relied Upon**

6,424,036	OKADA	7-2002
6,479,389	TSAI	11-2002
5,661,082	HSU	8-1997
6,457,234	EDELSTEIN	10-2002
5,565,378	HARADA	10-1996
5,320,689	MAHULIKAR	6-1994

**(9) Grounds of Rejection**

The following ground(s) of rejection are applicable to the appealed claims:

**DETAILED ACTION**

***Claim Rejections - 35 USC § 103***

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 74, and 75 are rejected under 35 U.S.C. 103(a) as being unpatentable over Okada 6,424,036 B1 in view of Tsai et al. 6,479,389 B1. Okada discloses (see, for example, FIG. 5) a semiconductor device comprising a protective insulating film (dielectric layer) 2, semiconductor substrate (substrate) 1, first barrier metal film (barrier layer) 14, copper pad film (copper layer) 19, and final protective insulating film (insulating layer) 16. In column 9, lines 9-10, Okada discloses the copper pad film having a thickness of 1.5  $\mu\text{m}$  or 15000 Angstroms (500 Angstroms to about 20,000 Angstroms). Okada does not disclose said copper layer having titanium implanted within and near only an upper surface of said copper layer. However, Tsai discloses (see, for example, FIG. 2c) a copper alloy film comprising a copper layer 26, and a copper alloy film (implanted with titanium) 27. In column 5, line 47, Tao discloses titanium as an alloying element. It would have been obvious to one of ordinary skill in the art at the time of invention to have said copper layer having titanium implanted within and near only an upper surface of said copper layer in order to improve electromigration resistance.

Regarding lines 5-6 of claim 74, the term "implanted" in the limitation "said copper layer having titanium implanted within and near only an upper surface of said copper layer" is a product-by-process limitation. Since the claims are directed toward product, and Okada in view of Tsai discloses titanium in an upper surface of a copper layer, Okada in view of Tsai still reads on the applicant's structural limitations. Please read the *Product-by-Process* paragraph below.

***Product-by-Process Limitations***

While not objectionable, the Office reminds Applicant that “product by process” limitations in claims drawn to structure are directed to the product, per se, no matter how actually made. *In re Hirao*, 190 USPQ 15 at 17 (footnote 3). See also, *In re Brown*, 173 USPQ 685; *In re Luck*, 177 USPQ 523; *In re Fessmann*, 180 USPQ 324; *In re Avery*, 186 USPQ 161; *In re Wethheim*, 191 USPQ 90 (209 USPQ 554 does not deal with this issue); *In re Marosi et al.*, 218 USPQ 289; and particularly *In re Thorpe*, 227 USPQ 964, all of which make it clear that it is the patentability of the final product per se which must be determined in a “product by process” claim, and not the patentability of the process, and that an old or obvious product produced by a new method is not patentable as a product, whether claimed in “product by process” claims or *otherwise*. Note that applicant has the burden of proof in such cases, as the above case law makes clear. Thus, no patentable weight will be given to those process steps which do not add structural limitations to the final product.

Regarding lines 9-10 of claim 74, the term “acts to reduce formation of copper oxide on said copper layer” in the limitation “wherein said implanted titanium acts to reduce formation of copper oxide on said copper layer”, it has been held that a recitation with respect to the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed apparatus from a prior art apparatus satisfying the claimed structural limitations. *Ex Parte Masham*, 2 USPQ F. 2d 1647 (1987). In any case, Tsai discloses (see, for example, column 4, lines 27-29) that copper alloy prevent oxidation of copper (i.e. acts to reduce formation of copper oxide on said copper layer).

Regarding claim 75, Okada in view of Tsai does not disclose said titanium implanted within said upper surface of said copper layer having a thickness of about 50 Angstroms to about 200 Angstroms. However, the thickness is a result effective variables that one of ordinary skill in the art would optimize for improving electromigration resistance. Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention was made to have said titanium implanted within said upper surface of said copper layer having a thickness of about 50 Angstroms to about 200 Angstroms, since it has been held that discovering the optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F. 2d 272, 205 USPQ 215 (CCPA 1980).

3. Claims 76 thru 78 are rejected under 35 U.S.C. 103(a) as being unpatentable over Okada '036 B1 in view of Tsai et al. '398 B1 as applied to claims 74, and 75 above, and further in view of Hsu et al. 5,661,082. Okada in view of Tsai does not disclose a passivation layer formed in contact with said copper layer. However, Hsu discloses (see, for example, FIG. 10) a bond pad comprising an antireflective coating (passivation layer) 393. In column 3, lines 38-41, Hsu discloses the antireflective coating comprising silicon nitride. It would have been obvious to one of ordinary skill in the art at the time of invention to have a passivation layer formed in contact with said copper layer in order to protect the copper pad film and prevent reflection.

Regarding claim 77, see, for example, FIG. 10 wherein Hsu discloses a via formed in the antireflective coating.

Regarding claim 78, Okada in view of Tsai does not disclose said dielectric film being formed of a material selected from the group consisting of phosphosilicate glass,

borophosphosilicate glass, silicon oxide, silicon nitride, and silicon oxynitride. However, Hsu discloses (see, for example, FIG. 10) a bond pad comprising an insulating layer (dielectric film) 36. In column 3, lines 14-17, Hsu discloses the insulating layer comprising phosphosilicate glass, and borophosphosilicate glass. Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention to have said dielectric film being formed of a material selected from the group consisting of phosphosilicate glass, borophosphosilicate glass, silicon oxide, silicon nitride, and silicon oxynitride in order to have a material that provides an adequate base for the copper pad film.

4. Claims 79, 80, 82, and 83 are rejected under 35 U.S.C. 103(a) as being unpatentable over Edelstein et al. 6,457,234 B1 in view of Harada et al. 5,565,378 in view of Mahulikar et al. 5,320,689. Edelstein discloses (see, for example, FIG. 7A) a conductive pad comprising a metal layer (conductive bond pad) 54, and metallic layer (titanium-aluminum-copper-nitrogen layer) 52. In column 3, lines 20-21, Edelstein discloses the metal layer is open to the atmosphere (copper oxide layer). In column 3, lines 17-18, Edelstein discloses the metal layer may be copper. In column 4, line 38, Edelstein discloses the second metal layer may be aluminum. In column 4, lines 47-54, Edelstein discloses the metallic layer is an alloy derived from the metal layer and the second metal layer. In this case, the alloy is AlCu. Edelstein does not disclose the titanium of the titanium-aluminum-copper nitrogen layer. However, Harada discloses (see, for example, column 6, lines 54-61) an aluminum alloy film, which may have titanium added. The metal element enhances the resistance to electromigration. Therefore, it would have been



obvious to one of ordinary skill in the art at the time of invention to have the titanium of the titanium-aluminum-copper nitrogen layer in order to enhance the resistance to electromigration.

Edelstein in view of Harada does not disclose nitrogen of the titanium-aluminum-copper nitrogen layer. However, Mahulikar discloses (see, for example, abstract) a composite copper alloy wherein the copper alloy is formed with nitrogen. The copper alloy has improved tribological and mechanical properties while maintaining useful electrical conductivity. Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention to have the nitrogen of the titanium-aluminum-copper nitrogen layer in order to improve tribological and mechanical properties while maintaining useful electrical conductivity.

Regarding claim 82, Edelstein in view of Harada in view of Mahulikar does not disclose said copper oxide layer having a thickness not greater than 300 Angstroms. However, it was well within the skills of an artisan in the art to optimize the performance of a semiconductor device by adjusting the thickness of a copper oxide layer in order to adequately protect an underlying layer. Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention was made to have said copper oxide layer having a thickness not greater than 300 Angstroms because it was well within the skills of an artisan to optimize the performance of a semiconductor device by adjusting the thickness of a copper layer in order to adequately protect an underlying layer. See *In re Aller*, 105 USPQ 233.

Regarding claim 83, see, for example, FIG. 7A wherein Edelstein discloses a wirebond (electrical conductor) 58.

**(10) Response to Argument**

Regarding the appellant's argument on page 7 of the appeal brief filed 6/12/07 that the resulting structure would not be that of the claimed titanium layer implanted within and near only an upper surface of the copper layer because the combination of references would only provide either a copper alloy layer formed merely on a top surface of the copper layer (e.g., Tsai, FIG. 2B) or a copper alloy formed throughout the entire depth of the copper layer (e.g., Tsai, FIG. 2C; col. 5, lines 59-64), this argument is not persuasive. First, FIG. 2B of Tsai is not relied upon by the Examiner in the final rejection mailed 11/3/06. FIG. 2C which is relied upon by the Examiner is a completely separate embodiment, and still reads on the applicant's claimed structural limitations.

Claim 74 of applicant's invention states "said copper layer having titanium implanted within and near only an upper surface of said copper layer". The claim does NOT state that the titanium can not eventually diffuse throughout the copper layer but only that, **when it is formed**, it is only implanted within and near only an upper surface of said copper layer. Therefore, in this case, Okada in view of Tsai still reads on the applicant's claims because FIG. 2C of Tsai discloses the copper alloy film with Ti (having titanium implanted within and near only an upper surface of said copper layer) 27 applied ONLY to the top surface of a pure copper layer 26. So even though Tsai states in the specification that the copper alloy forms throughout the entire depth of the copper layer, the claim does not state the copper alloy can not diffuse throughout the entire layer but only that titanium is implanted, or **initially** formed by process, within or near a top surface. Further, Tsai discloses that alloy layer 27 is a diffusion source, which further underscores the point that titanium is applied only to the top surface of the copper layer.

Regarding the appellant's argument of the term "implanted" in the limitation "implanted titanium", since the claims are directed towards product, this is a product-by- process limitation of forming a structure of a copper layer having titanium. The presence of process limitations on product claims, which product does not otherwise patentably distinguish over prior art, can not impart patentability to the product. In re Stephens 145 USPQ 656 (CCPA 1965). Since Okada in view of Tsai discloses the same structural limitations as those cited in the applicant's claims (i.e. a copper layer having titanium), the cited prior art still reads on the applicant's claims.

Regarding the applicant's argument on page 8, first paragraph that the claim limitations "acts to reduce formation of copper oxide on said copper layer", this argument is not persuasive. It has been held that a recitation with respect to the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed apparatus from a prior art apparatus satisfying the claimed structural limitations. Ex Parte Masham, 2 USPQ F. 2d 1647 (1987). In any case, adding titanium to copper would reduce the net amount of copper that could oxidize to form copper oxide, and also, Tsai specifically discloses (see, for example, column 4, lines 27-29) that copper alloy prevents oxidation of copper (i.e. acts to reduce formation of copper oxide on said copper layer).

Regarding the appellant's argument on bottom of page 8 that the thickness of the titanium alloy in Tsai would not be a result effective variable, this argument is not persuasive. As stated previously, the claims do not state that titanium can not diffuse throughout the entire copper layer, but only that, when first formed, that titanium is implanted within and near only an upper surface of said copper layer. Tsai discloses (see, for example, FIG. 2c) a copper alloy film with Ti 27 within and near only an upper surface of the copper layer 26. This copper alloy film with

Ti 27 shows a discrete thickness (see dotted line in FIG. 2C), and therefore, the thickness is still interpreted as a result effective variable.

Regarding the appellant's argument on page 9 that Hsu does not remedy the deficiencies of the Okada and Tsai combination, this argument is not persuasive. The Examiner has already addressed that Okada and Tsai do in fact disclose the appellant's claimed invention.

Regarding the appellant's argument on page 10 that Edelstein, Harada and Mahulikar are not properly combinable, and that there is no motivation to combine the references for the purpose of teaching or suggesting a titanium-aluminum-copper-nitrogen layer absent the impermissible use of hindsight using the claims of the present application as a roadmap, this argument is not persuasive. First, Edelstein, Harada and Mahulikar are properly combinable because they all relate to improving the properties (i.e. resistance) of a copper material. Further, it must be recognized that any judgment on obviousness is in any sense necessarily a reconstruction based upon hindsight reasoning. But so long as it takes into account only knowledge which was within the level of ordinary skill at the time the invention was made, and does not include knowledge gleaned only from the Applicant's disclosure, such a reconstruction is proper. In re McLaughlin, 443 F. 2d 1392; 170 USPQ 209 (CCPA 1971). In this case, the addition of Harada, and Mahulikar to Edelstein all involve the improvement of a copper film by adding elements to a copper film. Clearly, Harada (see, for example, column 6, lines 54-61) and Mahulikar (see, for example, abstract) provide reasons (see rejection above) so that such a reconstruction is proper (i.e. improve the properties of the copper film).

Regarding the appellant's argument on page 11, first paragraph that Harada relates to the improvement of an aluminum film by adding elements to the aluminum, this argument is not

persuasive. In column 6, lines 54-61, Harada discloses aluminum and AT LEAST one material, which includes copper and titanium, selected from a group added to the aluminum. Harada does not limit that only one material from the group may be selected but in fact allows additional elements (i.e. at least). Further, in claim 3, Harada discloses an aluminum alloy (which is aluminum and an additional metal), and a metal including at least one material including copper, AND titanium.

Regarding the appellant's argument that neither Harada nor Mahulikar provides any motivation to combine their teachings with bonding pad references in order to reduce oxidation of copper, this argument is not persuasive. The claims (i.e. claims 79, 80, 82, and 83) that are rejected by Edelstein in view of Harada in view of Mahulikar do not state "to reduce oxidation of copper". Edelstein and Harada and Mahulikar are combined for another motivation (i.e. to improve properties) as discussed in the rejection above.

#### **(11) Related Proceeding(s) Appendix**

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

Application/Control Number:  
10/656,182  
Art Unit: 2815

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Eugene Lee  
Primary Examiner  
AU 2815

EUGENE LEE  
PRIMARY EXAMINER

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November 14, 2007

Conferees:

Ken Parker  
SPE  
AU 2815

A handwritten signature in black ink, consisting of a single large loop.

Darren Schuberg  
SPE  
AU 2834

A handwritten signature in black ink, consisting of a series of loops and a large circle at the bottom.